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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 813 656 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
23.01.2002 Bulletin 2002/04

(21) Application number: **96906570.5**

(22) Date of filing: **26.02.1996**

(51) Int Cl.[7]: **F15C 3/04**, F15C 5/00

(86) International application number:
PCT/US96/02358

(87) International publication number:
WO 96/27742 (12.09.1996 Gazette 1996/41)

(54) **VALVE CONTROL**

VENTILSTEUERUNG

COMMANDE DE VANNE

(84) Designated Contracting States:
AT BE CH DE ES FR GB IT LI NL

(30) Priority: **08.03.1995 US 399081**

(43) Date of publication of application:
29.12.1997 Bulletin 1997/52

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EP 0 813 656 B1

Printed by Jouve, 75001 PARIS (FR)

Description

BACKGROUND OF THE INVENTION

[0001] Embodiments of the present invention relate generally to controlling a valve. Specifically, embodiments described herein relate to a valve control and a method for controlling a valve, or an array of valves.

[0002] In some uses, a pneumatically actuated and controlled valve, for example, may be used in a valve array comprising multiple valves. The position of each valve, i.e. open or closed, may be changed by applying a relatively reduced pressure or a relatively increased pressure, respectively, to the valve. For each valve to be controlled independently, each valve is operatively connected with its own control valve which may be a relatively expensive solenoid valve. Thus, two valves are needed to perform a certain task, one to perform the task and one to control the valve performing the task. This arrangement may be bulky and costly to manufacture and to use. Thus, it is desirable to have an improved way of controlling a valve. In one improvement, a given control valve, such as a solenoid valve, may be "shared" or used by a number of other valves through a network. Sharing of valves may result in cost savings, size and weight reductions, and/or reduction in complexity of the overall design of the valve array and its associated control structure.

[0003] US-A-3 540 477 and US-A-3 837 615 describe a valve control according to the preamble of claim 1.

SUMMARY OF THE INVENTION

[0004] One embodiment provides a valve control comprising a first valve fluidly connected with a first fluid conveying conduit and a second fluid conveying conduit. The first valve is movable between a first position where fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit and a second position where fluid does not communicate between the first fluid conveying conduit and the second fluid conveying conduit. A first source of relatively increased pressure and a first source of relatively reduced pressure are provided. A third conduit fluidly connects the first source of relatively increased pressure and the first source of relatively reduced pressure with the first valve. A third valve is fluidly connected with the third conduit. The third valve is movable between a first position where the first source of relatively increased pressure is fluidly connected with the third conduit and the first valve thereby moving the first valve toward its second position and a second position where the first source of relatively reduced pressure is fluidly connected with the third conduit and the first valve thereby moving the first valve toward its first position. A second valve is fluidly connected with the third conduit between the third valve and the first valve. The second valve is movable between a first position where fluid communicates between the first valve and the third valve and a second position where no fluid communicates between the first valve and the third valve, irrespective of the position of said third valve.

[0005] Another embodiment offers a method for controlling a valve. In this embodiment, a first valve is fluidly connected with a first fluid conveying conduit and a second fluid conveying conduit. The first valve is moved between a first position where fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit and a second position where fluid does not communicate between the first fluid conveying conduit and the second fluid conveying conduit. A first source of relatively increased pressure and a first source of relatively reduced pressure are fluidly connected with the first valve by a third conduit. A third valve is fluidly connected to the third conduit. The third valve is moved between a first position where the first source of relatively increased pressure is fluidly connected with the third conduit and the first valve thereby moving the first valve toward its second position and a second position where the first source of relatively reduced pressure is fluidly connected with the third conduit and the first valve thereby moving the first valve toward its first position. A second valve is fluidly connected with the third conduit between the third valve and the first valve. The second valve is moved between a first position where fluid communicates between the first valve and the third valve and a second position where no fluid communicates between the first valve and the third valve, irrespective of the position of said third valve.

[0006] According to the invention there is provided a valve control comprising a first valve fluidly connected with a first fluid conveying conduit and a second fluid conveying conduit. The first valve is movable between a first position where fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit and a second position where no fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit. A memory conduit is fluidly connected with the first valve for maintaining the first valve in the first position or the second position. A second valve is fluidly connected with the first valve and the memory conduit for either moving the first valve between the first position and the second position or for maintaining a pressure state of the memory conduit for keeping the first valve in either the first position or the second position depending upon the pressure state of the memory conduit.

[0007] In the method according to the invention, a first valve is fluidly connected with a first fluid conveying conduit and a second fluid conveying conduit. The first valve moves between a first position where fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit and a second position where no fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit. A second valve is fluidly connected with the first valve.

A memory conduit is fluidly connected fluidly between the first valve and the second valve for maintaining the first valve in the first position or the second position. The second valve is moved to move the first valve between the first position and the second position. The second valve is moved to maintain a pressure state of the memory conduit for keeping the first valve in either the first position or the second position depending upon the pressure state of the memory conduit.

[0008] The method of the invention also provides a number of first valves. Each of the number of first valves is fluidly connected with a first fluid conveying conduit and a second fluid conveying conduit. Each of the first valves is movable between a first position where fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit and a second position where no fluid communicates between the first fluid conveying conduit and the second fluid conveying conduit. At least one second valve is fluidly connected with each of the number of first valves with at least one memory conduit. A source of relatively increased pressure or relatively reduced pressure is fluidly connected with the at least one second valve. The at least one second valve is movable between a first position where the source of relatively increased pressure or relatively reduced pressure is fluidly connected with the at least one memory conduit and a second position where the source of relatively increased pressure or relatively reduced pressure is not fluidly connected with the at least one memory conduit. The at least one second valve is moved toward its first position to fluidly connect the at least one memory conduit and a first subset of the number of first valves with the source of relatively increased pressure or relatively reduced pressure and to move the first subset of the number of first valves toward a first predetermined one of its first position and its second position responsive to the relatively increased pressure or the relatively reduced pressure. The at least one second valve is moved toward its second position thereby maintaining the first subset of the number of first valves in the first predetermined one of its first position and its second position. The source of relatively increased pressure or relatively reduced pressure is fluidly connected with a second subset of the number of first valves to move the second subset of the number of first valves toward a second predetermined one of its first position and its second position responsive to the relatively increased pressure or the relatively reduced pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is a generic schematic diagram of an embodiment used to control a valve;

Fig. 2 is a sectional view of a portion of another embodiment similar to the embodiment of Fig. 1;

Fig. 3 is a schematic view of an exemplary valve array utilizing portions of the embodiment of Fig. 1; and

Fig. 4 is a sectional view of another embodiment similar to the embodiment of Fig. 2.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0010] Fig. 1 generally illustrates an embodiment 10 and a method for controlling a first valve 12. For the sake of clarity, the embodiment 10 and method are initially disclosed herein with respect to controlling only the first valve 12. However, it is to be recognized that the embodiment 10 and method may be used, with suitable modifications, to control a desired number of valves. Further, for the sake of clarity of understanding, the embodiment 10 is discussed with respect to a particular valve construction, illustrated in Fig. 2. Other constructions of the embodiment 10, such as that illustrated in Fig. 4 comprising an insert valve, are also possible. But, the embodiment 10 may be used, again with suitable modifications, to control valves of any appropriate construction. A valve may be controlled fluidly, electrostatically, electromagnetically, mechanically or the like. Additionally, method steps disclosed herein may be performed in any desired order and steps from one method may be combined with steps of another method to arrive at yet other methods. The embodiment 10 and method may be used to control a valve employed in any suitable type of fluidic system. The fluidic system may be incorporated into any suitable structure, such as an analytical instrument and the like. In some embodiments, the first valve 12, and other valves, may be a flow through valve fluidly connected with a fluid conveying conduit. Flow through valves are discussed, for instance, in US-A-5 542 444 filed on November 7, 1994 and assigned to the assignee of the present case. The entire disclosure of that copending patent application is incorporated herein by reference. Accordingly, the first fluid conveying conduit 14 and the second fluid conveying conduit 16 may be portions of the same fluid conveying conduit.

[0011] Referring to Fig. 1, the first valve 12 is fluidly connected between a first fluid conveying conduit 14 and a second fluid conveying conduit 16 such that operation of the first valve 12 determines whether or not fluid communicates between conduits 14 and 16. Specifically, when the first valve 12 is in a first position, fluid communicates between conduits 14 and 16, and when the first valve 12 is in a second position, fluid does not communicate between the conduits 14 and 16. Any desired fluid, such as gasses, liquids and the like, may be present in conduits 14 and 16. The first valve 12 is fluidly connected to a second valve 18 by a control or memory conduit 20. In some embodiments, there may be multiple second valves 18 fluidly connected with a single first valve 12. In other embodiments, there may be multiple first valves 12 fluidly connected with a single second

valve 18. Pressure in the control conduit 20 determines operation of the first valve 12. Thus, the control conduit 20 may be understood to be a memory conduit in that the pressure maintained in the memory conduit 20 maintains the first valve 12 in either the first position or the second position, i.e. the memory conduit 20 "remembers" the last pressure state applied to or the last position of the first valve 12. Thus, the pressure state of the memory conduit 20 determines the position of the first valve 12.

[0012] Operation of the second valve 18 determines pressure in the control conduit 20. Specifically, when the second valve 18 is in a first position, a third conduit 22 is fluidly connected with the control conduit 20 such that pressure in the third conduit 22 is exposed to the control conduit 20. When the second valve 18 is in a second position, the third conduit 22 does not fluidly communicate with the control conduit 20 and the pressure in the control conduit 20 is independent of or isolated from the pressure in the third conduit 22.

[0013] The second valve 18 is fluidly connected by the third conduit 22 to a third valve 24 and is fluidly connected by a fourth conduit 26 to a fourth valve 28. Pressure within the fourth conduit 26 controls operation of the second valve 18. In some embodiments, the second valve 18 may be maintained in either the first or second position by mechanical means, such as a spring and the like. In these embodiments, one of the pressure sources may not be needed and therefore it and associated structures may be eliminated. In any case, operation of the second valve 18 determines whether or not the control conduit 20 communicates fluidicly with the third conduit 22. In a particular embodiment, the fluid present in the control conduit 20 is a gas such as air and the like.

[0014] The fourth valve 28 is fluidly connected with a source 30 of relatively reduced pressure by a fifth conduit 32 and is fluidly connected with a source 34 of relatively increased pressure by a sixth conduit 36. The fourth valve 28 is operatively coupled with a controller, not shown, by connector 38, which may convey to the fourth valve 28 any suitable signal, such as an electronic signal, a fluidic or pneumatic signal and the like, for controlling operation of the fourth valve 28. Operation of the fourth valve 28 determines whether the source 30 or the source 34 is fluidly connected with the fourth conduit 26. When in a first position, the fourth valve 28 fluidly connects the sixth conduit 36 with the fourth conduit 26. In a second position, the fourth valve 28 fluidly connects the fifth conduit 32 with the fourth conduit 26.

[0015] In an exemplary embodiment, the source 30 provides a relatively reduced pressure that is approximately less than ambient pressure whereas the source 34 provides a relatively increased pressure which is approximately more than ambient pressure. The pressures provided by the sources 30 and 34 are predetermined for operating the second valve 18. In one embodiment, the pressure provided by source 34 is approximately more than the highest pressure expected to be present at any time in the control conduit 20 or the third conduit 22. Likewise, the pressure provided by source 30 is approximately less than the pressure expected at any time to be present in conduits 20 or 22. In a particular embodiment, the source 30 provides a relatively reduced pressure of about 67728 Pa (20 inches of mercury) and the source 34 provides a relatively increased pressure of about 137895 Pa (20 psig.) In some embodiments, the sources 30 and 34 may be integrated, such as in the form of a variable pressure source, e.g. a regulator, piston pump, and the like, which provide a relatively increased pressure or a relatively reduced pressure, as desired. In these embodiments, the fourth valve 28 and sources 30 and 34 may be eliminated.

[0016] The third valve 24 is operatively coupled with a controller, which is not shown, but may be the same as or substantially similar to the first-mentioned controller, by connector 40, which may convey to the third valve 24 any suitable signal, such as an electronic signal, a pneumatic signal and the like, for controlling operation of the third valve 24. In some embodiments, the connectors 38 and 40 may be replaced by mechanical actuators which operate the respective valves 24 and 28. In other embodiments, the third and fourth valves 24 and 28, respectively, may be electrically actuated, e.g. a solenoid valve, or mechanically actuated, e.g. by a spring.

[0017] The third valve 24 fluidly connects the third conduit 22 with either a seventh conduit 42 or an eighth conduit 44. The seventh conduit 42 fluidly connects the third valve 24 with a source 46 of relatively reduced pressure and the eighth conduit 44 fluidly connects the third valve 24 with a source 48 of relatively increased pressure. In a first position, the third valve 24 fluidly connects the eighth conduit 44 with the third conduit 22. In a second position, the third valve 24 fluidly connects the seventh conduit 42 with the third conduit 22.

[0018] In an exemplary embodiment, the source 46 provides a pressure which is approximately less than ambient pressure and the source 48 provides a pressure which is approximately more than ambient pressure. The pressures provided by the sources 46 and 48 are predetermined for operating the first valve 12. In a specific embodiment, the pressure provided by the source 48 is approximately more than the highest pressure expected to be present at any time in conduits 14 or 16 and the pressure provided by source 46 is approximately less than the pressure expected to be present at any time in conduits 14 or 16. In a specific embodiment, the source 46 provides a relatively reduced pressure of about 50796 Pa (15 inches of mercury) and the source 48 provides a relatively increased pressure of about 103421 Pa (15 psig.) In some embodiments, the sources 46 and 48 may be integrated, such as in the form of a variable pressure source, e.g. a regulator, piston pump, and the like. In these embodiments, the third valve 24 and sources 46 and 48 may be eliminated.

[0019] In a particular embodiment, with respect to the sources 30, 34, 46 and 48, the absolute pressure, i.e.

pressure value with respect to vacuum, provided by source 34 is approximately more than the absolute pressure provided by source 48. The absolute pressure provided by source 48 is approximately more than the highest pressure expected at any time to be present in conduits 14 and 16. The absolute pressure provided by source 30 is approximately lower than the absolute pressure provided by source 46. The absolute pressure provided by source 46 is approximately less than the lowest pressure expected at any time to be present in conduits 14 and 16. Pressure differentials exist among the sources 30, 34, 46 and 48 and the conduits 14 and 16. These pressure differentials assist in intended operation of the embodiment 10.

[0020] Illustrating by example, the embodiment 10 may be used with a membrane valve shown in Fig. 2. The membrane valve may be constructed by forming channels or conduits and spaces in a block 50 of material, such as a polymer and the like. The valve comprises a flexible member 52 which moves within the spaces formed in the block 50 responsive to a pressure exposed to the flexible member 52. More than one block 50 and more than one flexible member 52 may be used. For instance, a flexible member 52 may be placed between two blocks 50.

[0021] Considering valves 12 and 18, conduits 14 and 16 are fluidly connected with a volume 54 bounded by a first recessed surface 56 and the flexible member 52. A side of the flexible member 52 opposite to the side thereof facing the first recessed surface 56 faces a second recessed surface 58. The control conduit 20 terminates at the second recessed surface 58 such that pressure present in the control conduit 20 is exposed to the flexible member 52. When pressure in the control conduit 20 is approximately less than the fluid pressure in either conduit 14 or conduit 16, the flexible member 52 is moved toward the second recessed surface 58 thereby allowing fluid communication between conduits 14 and 16 through the volume 54. When the pressure in the control conduit 20 is approximately more than the pressure present in both conduits 14 and 16, the flexible member is moved toward the first recessed surface 56. With the flexible member 52 in this position, fluid communication between the conduits 14 and 16 is interrupted or limited.

[0022] Referring to Figs. 1 and 2, when the fourth valve 28 is in the first position, the relatively increased pressure from the source 34 is applied through the sixth conduit 36, the fourth valve 28 and the fourth conduit 26 to the side of the flexible member 52 facing the second recessed surface 58 of the second valve 18. The flexible member 52 moves toward the first recessed surface 56 of the second valve 18 thereby limiting fluid flow or fluid communication between the third conduit 22 and the control conduit 20. Thus, the pressure in the third conduit 22 may be varied by operation of the third valve 24 without effecting the first valve 12. Even when the relatively increased pressure from the source 48 is applied to the third conduit 22, the position of the second valve 18 is not changed. There is no fluid communication between the third conduit 22 and the control conduit 20. Pressure present in the fourth conduit 26 is approximately more than the pressure present in the third conduit 22 and the pressure present in the control conduit 20.

[0023] In one particular method, to change the position of the first valve 12, the appropriate pressure is first applied to the third conduit 22 by operating the third valve 24. For example, if it is desired to close the valve 12, the relatively increased pressure from source 48 is applied to the third conduit 22. In subsequent operations this will enable the first valve 12 to move into the second or closed position where there is no fluid communication between conduits 14 and 16. If it is desired to open the valve 12, the relatively reduced pressure from source 46 is applied to the third conduit 22. In subsequent operations this will enable the first valve 12 to move into the first or open position where there is fluid communication between conduits 14 and 16.

[0024] After the desired pressure is applied to the third conduit 22, the fourth valve 28 is operated such that the relatively reduced pressure from source 30 is applied through the fifth conduit 32, the fourth valve 28 and the fourth conduit 26 to a side of the flexible member 52 adjacent the second recessed surface 58 comprising the second valve 18. Since the absolute pressure provided by the source 30 is approximately less than any other pressure in the embodiment 10, the flexible member 52 comprising the second valve 18 moves toward the second recessed surface 58 comprising the second valve 18. Fluid communication between the third conduit 22 and the control conduit 20 has been established. It is to be noted that, in some embodiments, the order of the previous two operations may be reversed. That is, the fourth valve 28 may be operated first so as to enable conduit 22 to be fluidicly connected to memory conduit 20, followed by the actuation of valve 24 to select the pressure state to be present in the memory conduit. In this embodiment, however, the pressure state originally present in conduit 22 should match the pressure state of the memory conduit 20 to prevent unintentional changing of the position of valve 12.

[0025] The pressure now present in the control conduit 20 determines the position of the first valve 12 as determined by the pressure applied to the third conduit 22, which, in turn, is determined by the position of the third valve 24. After the first valve 12 moves or changes position, and before the third valve 24 moves or changes position, the fourth valve 28 may be moved toward its first position. Moving the fourth valve 28 toward its first position fluidly connects the source 34 of relatively increased pressure to the fourth conduit 26 through the sixth conduit 36 and the fourth valve 28. Application of the relatively increased pressure from source 34 moves the flexible member 52 toward the first recessed surface 56 of the second valve 18. Fluid communication be-

tween the third conduit 22 and the control conduit 20 is interrupted or reduced. With the second valve 18 in this position, the control conduit 20, whose pressure was equal to the pressure present in the third conduit 22, is fluidly isolated. The first valve 12 remains in its desired position irrespective of further changes of the pressure, caused by operation of the third valve 24, in the third conduit 22.

[0026] Since the second valve 18 holds or maintains a pressure condition in the control conduit 20 and thereby holds or maintains the position of the first valve 12, the valve 18 may be referred to as a "latch valve." Since moving or changing the position of the second valve 18 depends upon operation of the fourth valve 28, the fourth valve 28 may be referred to as an "enable valve" and the fourth conduit 26 may be referred to as an "enable line." Since, the third valve 24 determines the position to which the first valve 12 changes or moves, when the second valve 18 is open or enabled, the third valve 24 may be referred to as a "data valve" and the third conduit 22 may be referred to as the "data line." These terms are used to describe an exemplary embodiment 60 illustrated in Fig. 3 which is provided to facilitate understanding only. The enable valves 28 and the data valves 24 may be, in one embodiment, electrically powered solenoid valves. In a particular embodiment, the solenoid valves are Lee Valve Model LHDX0501650A (Westbrook, CT).

[0027] Referring to Fig. 3, sixteen valve pairs 62 are illustrated. Each valve pair comprises a first valve 12 and a second valve 18 and a memory conduit 20 between them superimposed on each other and collectively labeled 62. Multiple valve pairs 62 share a solenoid valve. In the illustrated embodiment, the sixteen valve pairs 62 are arranged in a matrix fashion, with their enable lines 26 fluidly connected to four enable valves 28 (solenoid valves in this embodiment) and their data lines 22 fluidly connected to four data valves 24 (solenoid valves in this embodiment). Fewer solenoid valves are required to control the array of first valves 12, thereby possibly producing a less expensive valve array control structure.

[0028] Any desired valve alignment or arrangement of valve operating positions may be achieved. For example, the valve pairs 62 in the leftmost "column", as viewed, may be operated by moving the data valves 24 to the desired valve 24 positions. Then, the leftmost, as viewed, enable valve 28 is actuated, so that only the first valves 12 associated with the leftmost valve pairs move toward the positions determined by the four data valves 24. A similar procedure may be used for each column of valve pairs 62, thereby producing any desired valve alignment. In this configuration, a total of four enable valves and four data valves, 28 and 24, respectively, control sixteen valve pairs 62. In a five by five configuration, a total of five enable valves and five data valves, 28 and 24, control twenty-five valve pairs 62.

[0029] To change the position of a desired number of valves that is less than the total number of valve pairs 62, only some of the columns may need to be operated. It is possible to group the individual valves in columns to perform a particular application with a reduced number of valve operations. In order to provide more favorable groupings or arrangements of valves, more than one second valve 18 may be operatively or fluidly associated with a particular first valve 12. It is also possible to fluidly associate more than one first valve 12 with a particular second valve 18, if all first valves 12 so associated always operate conjointly or in tandem.

[0030] Maintenance of the position of the first valve 12 is due to the maintenance of pressure in the control conduit 20. Operation of a particular array of valves may require a particular memory conduit to maintain a pressure state for an extended time. To maintain the position of a first valve 12 for an extended time period, it may be desirable to periodically refresh the pressure state in memory conduit 20 by performing a valve operation procedure that refreshes or recharges the pressure state in memory conduit 20. Alternatively, increasing volume of the memory conduit 20, may increase the volume of pressurized fluid, which may maintain the position of a given first valve 12 for extended time periods without refreshment of the pressure within the memory conduit 20. However, this method might decrease response time of the embodiments 10 and 60 to desired valve position changes.

[0031] A finite amount of time may be needed for the third valve 24 and the fourth valve 28 to operate, for the pressures in conduits 20, 22 and 26 to change, and for the valves 12 and 18 to operate. It may be desirable to include time delays in valve operating sequences. Duration of the time delays may vary, e.g. with geometry or proximity of the valve pairs 62 (particularly the dimensions of conduits 20, 22, and 26), the pressures provided by sources 30, 34, 46 and 48, and the specific operating characteristics of the valves 12, 18, 24 and 28. In an exemplary embodiment, a time delay of about 0.02 seconds is inserted between operation of the third valves 24 and operation of the fourth valves 28, a time delay of about 0.04 seconds is inserted between subsequent operations of the fourth valves 28, and a time delay of about 0.02 seconds is inserted between operation of the fourth valves 28 and further operation of the third valves 24.

[0032] In still a further embodiment, it is possible to have the third valve 24 directly control the position of the first valve 12. Specifically, the fourth valve 28 may be operated such that the source 30 of relatively reduced pressure is fluidly connected with the fourth conduit 26 through the fifth conduit 32 and the fourth valve 28. Responsively, the second valve 18 is operated such that the third conduit 22 communicates fluidly with the control conduit 20. In other words, the second valve 18 is maintained in its first position thereby allowing fluid communication between the first valve 12 and the third valve 24. The third valve 24 can be repeatedly operated

such that the third valve 24 sequentially fluidly connects the source 46 of relatively reduced pressure and the source 48 of relatively increased pressure to the third conduit 22 and to the control conduit 20. Accordingly, the first valve 12 changes position dependent upon which source 46 or 48 is fluidly connected with the third conduit 22 by the third valve 24.

[0033] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included just for the sole purpose of increasing intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. A valve control comprising:

   (a) a first valve (12) fluidly connected with a first fluid conveying conduit (14) and a second fluid conveying conduit (16), the first valve (12) movable between a first position where fluid communicates between the first fluid conveying conduit (14) and the second fluid conveying conduit (16) and a second position where fluid does not communicate between the first fluid conveying conduit (14) and the second fluid conveying conduit (16);
   (b) a first source of relatively increased pressure (48);
   (c) a first source of relatively reduced pressure (46);
   (d) a third conduit (20, 22) fluidly connecting the first source of relatively increased pressure (48) and the first source of relatively reduced pressure (46) with the first valve (12);
   (e) a third valve (24) fluidly connected with the third conduit (20, 22), the third valve (24) movable between a first position where the first source of relatively increased pressure (48) is fluidly connected with the third conduit (20, 22) and the first valve (12) thereby moving the first valve (12) toward its second position and a second position where the first source of relatively reduced pressure (46) is fluidly connected with the third conduit (20, 22) and the first valve (12) thereby moving the first valve (12) toward its first position;

   characterized by

   a second valve (18) fluidly connected with the third conduit (20, 22) between the third valve (24) and the first valve (12), the second valve (18) movable between a first position where fluid communicates between the first valve (12) and the third valve (24) and a second position where no fluid communicates between the first (12) and the third valve (24), irrespective of the position of said third valve (24).

2. The valve control as defined in claim 1 wherein the first valve (12) is a membrane valve.

3. The valve control as defined in claims 1 or 2 wherein the first source of relatively increased pressure (48) provides a relatively increased pressure which is approximately more than ambient pressure.

4. The valve control as defined in claim 3 wherein the relatively increased pressure is about 103421 Pa (15 psig).

5. The valve control as defined in one or more of claims 1-4 wherein the first source of relatively reduced pressure (46) provides a relatively reduced pressure which is approximately less than ambient pressure.

6. The valve control as defined in claim 5 wherein the relatively reduced pressure is about 50796 Pa (15 inches of mercury).

7. The valve control as defined in claims 1 or 2 wherein the relatively increased pressure is approximately more than a highest pressure expected to be present at any time in the first fluid conveying conduit (14) and the second fluid conveying conduit (16).

8. The valve control as defined in claims 1 or 2 wherein the relatively reduced pressure is approximately less than a pressure expected to be present at any time in the first fluid conveying conduit (14) and the second fluid conveying conduit (16).

9. The valve control as defined one or more of claims 1-8 further comprising:

   (g) a second source of relatively increased pressure (34);
   (h) a second source of relatively reduced pressure (30) ;
   (i) a fourth valve (28) fluidly connecting the second source of relatively increased pressure (34) and the second source of relatively reduced pressure (30) to the second valve (18), the fourth valve (28) movable between a first position where the second source of relatively increased pressure (34) is fluidly connected with the second valve (18) thereby moving the second valve (18) toward its second position and a second position where the second source of relatively reduced pressure (30) is fluidly connected with the second valve (18) thereby

moving the second valve (18) toward its first position.

10. The valve control as defined in claim 9 wherein the second source of relatively reduced pressure (30) provides a relatively reduced pressure that is approximately less than ambient pressure.

11. The valve control as defined in claim 10 wherein the relatively reduced pressure provided by the second source of relatively reduced pressure (30) is approximately less than pressure expected at any time to be present in the third conduit (20, 22).

12. The valve control as defined in claim 10 wherein the relatively reduced pressure is about 67728 Pa (20 inches of mercury).

13. The valve control as defined in claim 9 wherein the second source of relatively increased pressure (34) provides a relatively increased pressure which is approximately more than ambient pressure.

14. The valve control as defined in claim 13 wherein the relatively increased pressure is approximately more than highest pressure expected to be present at any time in the third conduit (20, 22).

15. The valve control as defined in claim 13 wherein the relatively increased pressure is about 137895 Pa (20 psig).

16. The valve control as defined in one or more of claims 1-15 wherein the third conduit (20, 22) comprises a memory conduit (20) fluidly connected with the first valve (12) for maintaining the first valve (12) in its first position or in its second position; and wherein

the second valve (18) is fluidly connected with the first valve (12) and the memory conduit (20) for either moving the first valve (12) between its first position and its second position or for maintaining a pressure state of the memory conduit (20) for keeping the first valve (12) in either its first position or its second position depending upon the pressure state of the memory conduit (20).

17. A method of controlling a valve, the method comprising the steps of:

(a) fluidly connecting a first valve (12) with a first fluid conveying conduit (14) and a second fluid conveying conduit (16);
(b) moving the first valve (12) between a first position where fluid communicates between the first fluid conveying conduit (14) and the second fluid conveying conduit (16) and a second position where fluid does not communicate between the first fluid conveying conduit (14) and the second fluid conveying conduit (16);
(c) fluidly connecting a first source of relatively increased pressure (48) and a first source of relatively reduced pressure (46) with the first valve (12) by a third conduit (20, 22);
(d) fluidly connecting a third valve (24) to the third conduit (20, 22);
(e) moving the third valve (24) between a first position where the first source of relatively increased pressure (48) is fluidly connected with the third conduit (20, 22) and the first valve (12) thereby moving the first valve (12) toward its second position and a second position where the first source of relatively reduced pressure (46) is fluidly connected with the third conduit (20, 22) and the first valve (12) thereby moving the first valve (12) toward its first position;
(f) fluidly connecting a second valve (18) with the third conduit (20, 22) between the third valve (24) and the first valve (12); and
(g) moving the second valve (18) between a first position where fluid communicates between the first valve (12) and the third valve (24) and a second position where there no fluid communicates between the first valve (12) and the third valve (24), irrespective of the position of said third valve (24).

18. The method as defined in claim 17 further comprising the steps of:

(h) fluidly connecting a second source of relatively increased pressure (34), a second source of relatively reduced pressure (30) and the second valve (18) with a fourth valve (28); and
(i) moving the fourth valve (28) between a first position where the second source of relatively increased pressure (34) is fluidly connected with the second valve (18) thereby moving the second valve (18) toward its second position and a second position where the second source of relatively reduced pressure (30) is fluidly connected with the second valve (18) thereby moving the second valve (18) toward its first position.

19. The method as defined in claim 17 wherein the third conduit (20, 22) comprises a memory conduit (20), the method further comprising the steps of:

(h) fluidly connecting the memory conduit (20) between the first valve (12) and the second valve (18) for maintaining the first valve (12) in its first position or its second position;
(i) moving the second valve (18) to move the first valve (12) between its first position and its second position; and

(j) moving the second valve (18) to maintain a pressure state of the memory conduit (20) for keeping the first valve (12) in either its first position or its second position depending upon the pressure state of the memory conduit (20).

20. The method as defined in claim 17 further comprising the steps of:

providing a number of the first valves (12), each of the number of first valves (12) being fluidly connected with the first fluid conveying conduit (14) and the second fluid conveying conduit (16), each of the first valves (12) being movable between a first position where fluid communicates between the first fluid conveying conduit (14) and the second fluid conveying conduit (16) and a second position where no fluid communicates between the first fluid conveying conduit (14) and the second fluid conveying conduit (16);
providing at least one second valve (18) and a corresponding number of the third conduits (20, 22), each third conduit (20, 22) including a memory conduit (20);
fluidly connecting the at least one second valve (18) with each of the number of first valves (12) with at least one memory conduit (20);
fluidly connecting the source of relatively increased pressure (48) or the source of relatively reduced pressure (46) with the at least one second valve (18), the at least one second valve (18) being movable between its first position where the source of relatively increased pressure (48) or the source of relatively reduced pressure (46) is fluidly connected with the at least one memory conduit (20) and its second position where the source of relatively increased pressure (48) or the source of relatively reduced pressure (46) is not fluidly connected with the at least one memory conduit (20);
moving the at least one second valve (18) toward its first position to fluidly connect the at least one memory conduit (20) and a first subset of the number of first valves (12) with the source of relatively increased pressure (48) or the source of relatively reduced pressure (46) and to move the first subset' of the number of first valves (12) toward a first predetermined one of its first position and its second position responsive to the relatively increased pressure or the relatively reduced pressure;
moving the at least one second valve (18) toward its second position thereby maintaining the first subset of the number of first valves (12) in the first predetermined one of its first position and its second position; and
fluidly connecting the source of relatively increased pressure (48) or the source of relatively reduced pressure (46) with a second subset of the number of first valves (12) to move the second subset of the number of first valves (12) toward a second predetermined one of its first position and its second position responsive to the relatively increased pressure or the relatively reduced pressure.

Patentansprüche

1. Eine Ventilsteuerung, die folgendes umfasst:

(a) ein erstes Ventil (12), das mit einer ersten Fluidbeförderungsleitung (14) und einer zweiten Fluidbeförderungsleitung (16) in fluidischer Verbindung steht, wobei das erste Ventil (12) zwischen einer ersten Stellung, in der das Fluid zwischen der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) strömt, und einer zweiten Stellung bewegt werden kann, in der das Fluid nicht zwischen der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) strömt;
(b) eine erste Quelle eines relativ erhöhten Drucks (48) ;
(c) eine erste Quelle eines relativ gesenkten Drucks (46) ;
(d) eine dritte Leitung (20, 22), die die erste Quelle relativ erhöhten Drucks (48) und die erste Quelle relativ gesenkten Drucks (46) mit dem ersten Ventil (12) fluidisch verbindet;
(e) ein drittes Ventil (24), das mit der dritten Leitung (20, 22) fluidisch verbunden wird, wobei das dritte Ventil (24) zwischen einer ersten Stellung, in der die erste Quelle relativ erhöhten Drucks (48) mit der dritten Leitung (20, 22) und dem ersten Ventil (12) fluidisch verbunden wird, wodurch das erste Ventil (12) in Richtung seiner zweiten Stellung bewegt wird, und einer zweiten Stellung bewegt werden kann, in der die erste Quelle relativ gesenkten Drucks (46) mit der dritten Leitung (20, 22) und dem ersten Ventil (12) fluidisch verbunden wird, wodurch das erste Ventil (12) in Richtung seiner ersten Stellung bewegt wird;

dadurch gekennzeichnet, dass

ein zweites Ventil (18) mit der dritten Leitung (20, 22) zwischen dem dritten Ventil (24) und dem ersten Ventil (12) fluidisch verbunden ist, wobei das zweite Ventil (18) ungeachtet von der Stellung des dritten Ventils (24), zwischen einer ersten Stellung, in der das Fluid zwischen dem ersten Ventil (12) und dem dritten Ventil (24) strömt, und einer zweiten

Stellung bewegt werden kann, in der kein Fluid zwischen dem ersten (12) und dem dritten Ventil (24) strömt.

2. Die Ventilsteuerung, wie im Anspruch 1 definierr, wobei das erste Ventil (12) ein Membranventil ist.

3. Die Ventilsteuerung, wie im Anspruch 1 oder 2 definiert, wobei die erste Quelle relativ erhöhten Drucks (48) einen relativ erhöhten Druck bereitstellt, der in etwa über dem Umgebungsdruck liegt.

4. Die Ventilsteuerung, wie im Anspruch 3 definiert, wobei der relativ erhöhte Druck in etwa 103421 Pa (15 psig) beträgt.

5. Die Ventilsteuerung, wie in einem oder mehreren der Ansprüche 1-4 definiert, wobei die erste Quelle relativ gesenkten Drucks (46) einen relativ gesenkten Druck bereitstellt, der in etwa unter dem Umgebungsdruck liegt.

6. Die Ventilsteuerung, wie im Anspruch 5 definiert, wobei der relativ gesenkte Druck in etwa 50796 Pa (15 Zoll Quecksilbersäule) beträgt.

7. Die Ventilsteuerung, wie in den Ansprüchen 1 oder 2 definiert, wobei der relativ erhöhte Druck in etwa über einem Höchstdruck liegt, von dem erwartet wird, dass er jederzeit in der ersten Fluidbeförderungsleitung (14) und in der zweiten Fluidbeförderungsleitung (16) vorliegt.

8. Die Ventilsteuerung, wie in den Ansprüchen 1 oder 2 definiert, wobei der relativ gesenkte Druck in etwa unter einem Druck liegt, von dem erwartet wird, dass er jederzeit in der ersten Fluidbeförderungsleitung (14) und in der zweiten Fluidbeförderungsleitung (16) vorliegt.

9. Die Ventilsteuerung, wie in einem oder mehreren der Ansprüche 1-8 definiert, die weiterhin folgendes umfasst:

(g) eine zweite Quelle relativ erhöhten Drucks (34);
(h) eine zweite Quelle relativ gesenkten Drucks (30);
(i) ein viertes Ventil (28), das die zweite Quelle relativ erhöhten Drucks (34) und die zweite Quelle relativ gesenkten Drucks (30) mit dem zweiten Ventil (18) fluidisch verbindet, wobei das vierte Ventil (28) zwischen einer ersten Stellung, in der die zweite Quelle relativ erhöhten Drucks (34) mit dem zweiten Ventil (18) fluidisch verbunden wird, wodurch das zweite Ventil (18) in Richtung seiner zweiten Stellung bewegt wird, und einer zweiten Stellung bewegt werden kann, in der die zweite Quelle relativ gesenkten Drucks (30) mit dem zweiten Ventil (18) fluidisch verbunden wird, wodurch das zweite Ventil (18) in Richtung seiner ersten Stellung bewegt wird.

10. Die Ventilsteuerung, wie im Anspruch 9 definiert, wobei die zweite Quelle relativ gesenkten Drucks (30) einen relativ gesenkten Druck bereitstellt, der in etwa unter dem Umgebungsdruck liegt.

11. Die Ventilsteuerung, wie im Anspruch 10 definiert, wobei der von der zweiten Quelle relativ gesenkten Drucks (30) bereitgestellte relativ gesenkte Druck in etwa unter dem Druck liegt, von dem erwartet wird, dass er jederzeit in der dritten Leitung (20, 22) vorliegt.

12. Die Ventilsteuerung, wie im Anspruch 10 definiert, wobei der relativ gesenkte Druck in etwa 67728 Pa (20 Zoll Quecksilbersäule) beträgt.

13. Die Ventilsteuerung, wie im Anspruch 9 definiert, wobei die zweite Quelle relativ erhöhten Drucks (34) einen relativ erhöhten Druck bereitstellt, der in etwa über dem Umgebungsdruck liegt.

14. Die Ventilsteuerung, wie im Anspruch 13 definiert, wobei der relativ erhöhte Druck in etwa über dem Höchstdruck liegt, von dem erwartet wird, dass er jederzeit in der dritten Leitung (20, 22) vorliegt.

15. Die Ventilsteuerung, wie im Anspruch 13 definiert, wobei der relativ erhöhte Druck in etwa 137895 Pa (20 psig) beträgt.

16. Die Ventilsteuerung, wie in einem oder mehreren der Ansprüche 1-15 definiert, wobei die dritte Leitung (20, 22) eine Speicherleitung (20) umfasst, die mit dem ersten Ventil (12) fluidisch verbunden wird, um das erste Ventil (12) in seiner ersten Stellung oder in seiner zweiten Stellung zu erhalten; und wobei

das zweite Ventil (18) mit dem ersten Ventil (12) und der Speicherleitung (20) fluidisch verbunden ist, um das erste Ventil (12) entweder zwischen seiner ersten Stellung und seiner zweiten Stellung zu bewegen oder um einen Druckzustand der Speicherleitung (20) aufrechtzuerhalten, um das erste Ventil (12) abhängig vom Druckzustand der Speicherleitung (20) entweder in seiner ersten Stellung oder in seiner zweiten Stellung zu halten.

17. Ein Verfahren zum Betätigen eines Ventils, wobei das Verfahren folgende Schritte umfasst:

(a) das fluidische Verbinden eines ersten Ventils (12) mit einer ersten Fluidbeförderungslei-

tung (14) und einer zweiten Fluidbeförderungsleitung (16);
(b) das Bewegen des ersten Ventils (12) zwischen einer ersten Stellung, in der das Fluid zwischen der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) strömt, und einer zweiten Stellung, worin das Fluid nicht zwischen der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) strömt;
(c) das fluidische Verbinden einer ersten Quelle relativ erhöhten Drucks (48) und einer ersten Quelle relativ gesenkten Drucks (46) mit dem ersten Ventil (12), und zwar mittels einer dritten Leitung (20, 22):
(d) das fluidische Verbinden eines dritten Ventils (24) mit der dritten Leitung (20, 22);
(e) das Bewegen des dritten Ventils (24) zwischen einer ersten Stellung, in der die erste Quelle relativ erhöhten Drucks (48) mit der dritten Leitung (20, 22) und dem ersten Ventil (12) fluidisch verbunden wird, wodurch das erste Ventil (12) in Richtung seiner zweiten Stellung bewegt wird, und einer zweiten Stellung, worin die erste Quelle relativ gesenkten Drucks (46) mit der dritten Leitung (20, 22) und dem ersten Ventil (12) fluidisch verbunden wird, wodurch das erste Ventil (12) in Richtung seiner ersten Stellung bewegt wird;
(f) das fluidische Verbinden eines zweiten Ventils (18) mit der dritten Leitung (20, 22) zwischen dem dritten Ventil (24) und dem ersten Ventil (12) ; und
(g) das Bewegen des zweiten Ventils (18) zwischen einer ersten Stellung, in der das Fluid zwischen dem ersten Ventil (12) und dem dritten Ventil (24) strömt, und einer zweiten Stellung, in der kein Fluid zwischen dem ersten Ventil (12) und dem dritten Ventil (24) strömt, und zwar ungeachtet der Stellung des dritten Ventils (24).

18. Das Verfahren, wie im Anspruch 17 definiert, das weiterhin die folgenden Schritte umfasst:

(h) das fluidische Verbinden einer zweiten Quelle relativ erhöhten Drucks (34), einer zweiten Quelle relativ gesenkten Drucks (30) und des Ventils (18) mit einem vierten Ventil (28); und
(i) das Bewegen des vierten Ventils (28) zwischen einer ersten Stellung, in der die zweite Quelle relativ erhöhten Drucks (34) mit dem zweiten Ventil (18) fluidisch verbunden wird, wodurch das zweite Ventil (18) in Richtung seiner zweiten Stellung bewegt wird, und einer zweiten Stellung, in der die zweite Quelle relativ gesenkten Drucks (30) mit dem zweiten Ventil (18) fluidisch verbunden wird, wodurch das zweite Ventil (18) in Richtung seiner ersten Stellung bewegt wird.

19. Das Verfahren, wie im Anspruch 17 definiert, worin die dritte Leitung (20, 22) eine Speicherleitung (20) umfasst, wobei das Verfahren weiterhin folgende Schritte umfasst:

(h) das fluidische Verbinden der Speicherleitung (20) zwischen dem ersten Ventil (12) und dem zweiten Ventil (18), um das erste Ventil (12) in seiner ersten Stellung oder in seiner zweiten Stellung zu erhalten;
(i) das Bewegen des zweiten Ventils (18) zum Bewegen des ersten Ventils (12) zwischen seiner ersten Stellung und seiner zweiten Stellung; und
(j) das Bewegen des zweiten Ventils (18) zum Aufrechterhalten eines Druckzustands der Speicherleitung (20), um das erste Ventil (12) abhängig vom Druckzustand der Speicherleitung (20) entweder in seiner ersten Stellung oder in seiner zweiten Stellung zu halten.

20. Das Verfahren, wie im Anspruch 17 definiert, das weiterhin die folgenden Schritte umfasst:

das Bereitstellen einer Anzahl an ersten Ventilen (12), wobei jedes der Anzahl an ersten Ventilen (12) mit der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) fluidisch verbunden ist, wobei jedes der ersten Ventile (12) zwischen einer ersten Stellung, in der das Fluid zwischen der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) strömt, und einer zweiten Stellung bewegt werden kann, in der kein Fluid zwischen der ersten Fluidbeförderungsleitung (14) und der zweiten Fluidbeförderungsleitung (16) strömt;
das Bereitstellen von mindestens einem zweiten Ventil (18) und einer entsprechenden Anzahl dritter Leitungen (20, 22), wobei jede dritte Leitung (20, 22) eine Speicherleitung (20) einschließt;
das fluidische Verbinden des mindestens einen zweiten Ventils (18) mit jedem der Anzahl an ersten Ventilen (12) über mindestens eine Speicherleitung (20);
das fluidische Verbinden der Quelle relativ erhöhten Druck (48) oder der Quelle relativ gesenkten Drucks (46) mit dem mindestens einen zweiten Ventil (18), wobei das mindestens eine zweite Ventil (18) zwischen seiner ersten Stellung, in der die Quelle relativ erhöhten Drucks (48) oder die Quelle relativ gesenkten Drucks (46) mit der mindestens einen Speicherleitung

(20) fluidisch verbunden ist, und seiner zweiten Stellung bewegt werden kann, in der die Quelle relativ erhöhten Drucks (48) oder die Quelle relativ gesenkten Drucks (46) nicht mit der mindestens einen Speicherleitung (20) fluidisch verbunden ist;
das Bewegen des mindestens einen zweiten Ventils (18) in Richtung seiner ersten Stellung, um die mindestens eine Speicherleitung (20) und eine erste Untermenge der Anzahl an ersten Ventilen (12) mit der Quelle relativ erhöhten Drucks (48) oder mit der Quelle relativ gesenkten Drucks (46) fluidisch zu verbinden und um die erste Untermenge der Anzahl an ersten Ventilen (12) als Reaktion auf den relativ erhöhten Druck oder den relativ gesenkten Druck in Richtung einer ersten vorbestimmten Stellung seiner ersten Stellung und seiner zweiten Stellung zu bewegen;
das Bewegen des mindestens einen zweiten Ventils (18) in Richtung seiner zweiten Stellung, wodurch die erste Untermenge der Anzahl an ersten Ventilen (12) in der ersten vorbestimmten Stellung seiner ersten Stellung und seiner zweiten Stellung beibehalten bleibt; und
das fluidische Verbinden der Quelle relativ erhöhten Drucks (48) oder der Quelle relativ gesenkten Drucks (46) mit einer zweiten Untermenge der Anzahl an ersten Ventilen (12), um die zweite Untermenge der Anzahl an ersten Ventilen (12) als Reaktion auf den relativ erhöhten Druck oder den relativ gesenkten Druck in Richtung einer zweiten vorbestimmten Stellung seiner ersten Stellung und seiner zweiten Stellung zu bewegen.

Revendications

1. Commande de soupape comportant :

(a) une première soupape (12) reliée de manière fluidique à un premier conduit de transport de fluide (14) et un deuxième conduit de transport de fluide (16), la première soupape (12) étant mobiles entre une première position où le fluide communique entre le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16) et une deuxième position où le fluide ne communique pas entre le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16);
(b) une première source de pression relativement accrue (48) ;
(c) une première source de pression relativement réduite (46);
(d) un troisième conduit (20, 22) reliant de manière fluidique la première source de pression relativement accrue (48) et la première source de pression relativement réduite (46) à la première soupape (12);
(e) une troisième soupape (24) reliée de manière fluidique au troisième conduit (20, 22), la troisième soupape (24) étant mobile entre une première position où la première source de pression relativement accrue (48) est reliée de manière fluidique au troisième conduit (20, 22) et la première soupape (12) en déplaçant ainsi la première soupape (12) vers sa deuxième position et une deuxième position où la première source de pression relativement réduite (46) est reliée de manière fluidique au troisième conduit (20, 22) et la première soupape (12) en déplaçant ainsi la première soupape (12) vers sa première position; **caractérisée par**

une deuxième soupape (18) reliée de manière fluidique au troisième conduit (20, 22) entre la troisième soupape (24) et la première soupape (12), la deuxième soupape (18) étant mobile entre une première position où le fluide communique entre la première soupape (12) et la troisième soupape (24) et une deuxième position où aucun fluide ne communique entre la première (12) et la troisième soupape (24), indépendamment de la position de ladite troisième soupape (24).

2. Commande de soupape selon la revendication 1, dans laquelle la première soupape (12) est une soupape à membrane.

3. Commande de soupape selon la revendication 1 ou 2, dans laquelle la première source de pression relativement accrue (48) fournit une pression relativement accrue qui est approximativement supérieure à la pression ambiante.

4. Commande de soupape selon la revendication 3, dans laquelle la pression relativement accrue est d'environ 103421 Pa (15 psi).

5. Commande de soupape selon une ou plusieurs des revendications 1 à 4, dans laquelle la première source de pression relativement réduite (46) fournit une pression relativement réduite qui est approximativement inférieure à la pression ambiante.

6. Commande de soupape selon la revendication 5, dans laquelle la pression relativement réduite est d'environ 50796 Pa (15 pouces de mercure).

7. Commande de soupape selon la revendication 1 ou 2, dans laquelle la pression relativement accrue est approximativement supérieure à une pression la plus élevée prévue pour être présente à tout moment dans le premier conduit de transport de fluide

(14) et le deuxième conduit de transport de fluide (16).

8. Commande de soupape selon la revendication 1 ou 2, dans laquelle la pression relativement réduite est approximativement inférieure à une pression prévue pour être présente à tout moment dans le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16).

9. Commande de soupape selon une ou plusieurs des revendications 1 à 8, comportant en outre :

(g) une deuxième source de pression relativement accrue (34) ;
(h) une deuxième source de pression relativement réduite (30) ;
(i) une quatrième soupape (28) reliant de manière fluidique la deuxième source de pression relativement accrue (34) et la deuxième source de pression relativement réduite (30) à la deuxième soupape (18), la quatrième soupape (28) étant mobile entre une première position où la deuxième source de pression relativement accrue (34) est reliée de manière fluidique à la deuxième soupape (18) en déplaçant ainsi la deuxième soupape (18) vers sa deuxième position et une deuxième position où la deuxième source de pression relativement réduite (30) est reliée de manière fluidique à la deuxième soupape (18) en déplaçant ainsi la deuxième soupape (18) vers sa première position.

10. Commande de soupape selon la revendication 9, dans laquelle la deuxième source de pression relativement réduite (30) fournit une pression relativement réduite qui est approximativement inférieure à la pression ambiante.

11. Commande de soupape selon la revendication 10, dans laquelle la pression relativement réduite fournie par la deuxième source de pression relativement réduite (30) est approximativement inférieure à la pression prévue à tout moment pour être présente dans le troisième conduit (20, 22).

12. Commande de soupape selon la revendication 10, dans laquelle la pression relativement réduite est d'environ 67728 Pa (20 pouces de mercure).

13. Commande de soupape selon la revendication 9, dans laquelle la deuxième source de pression relativement accrue (34) fournit une pression relativement accrue qui est approximativement supérieure à la pression ambiante.

14. Commande de soupape selon la revendication 13, dans laquelle la pression relativement accrue est approximativement supérieure à la pression la plus élevée prévue pour être présente à tout moment dans le troisième conduit (20, 22).

15. Commande de soupape selon la revendication 13, dans laquelle la pression relativement accrue est d'environ 137895 (20 psi).

16. Commande de soupape selon une ou plusieurs des revendications 1 à 15, dans laquelle le troisième conduit (20, 22) comporte un conduit à mémoire (20) relié de manière fluidique à la première soupape (12) afin de maintenir la première soupape (12) dans sa première position ou sa deuxième position; et dans laquelle la deuxième soupape (18) est reliée de manière fluidique à la première soupape (12) et au conduit à mémoire (20) afin de déplacer la première soupape (12) entre sa première position et sa deuxième position ou bien afin de maintenir un état de pression du conduit à mémoire (20) de façon maintenir la première soupape (12) dans sa première position ou sa deuxième position en fonction de l'état de pression du conduit à mémoire (20).

17. Procédé de commande d'une soupape, le procédé comportant les étapes consistant à :

(a) relier de manière fluidique une première soupape (12) à un premier conduit de transport de fluide (14) et à un deuxième conduit de transport de fluide (16);
(b) déplacer la première soupape (12) entre une première position ou le fluide communique entre le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16) et une deuxième position où le fluide ne communique pas entre le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16);
(c) relier de manière fluidique une première source de pression relativement accrue (48) et une première source de pression relativement réduite (46) à la première soupape (12) par un troisième conduit (20, 22);
(d) relier de manière fluidique une troisième soupape (24) au troisième conduit (20, 22);
(e) déplacer la troisième soupape (24) entre une première position où la première source de pression relativement accrue (48) est reliée de manière fluidique au troisième conduit (20, 22) et à la première soupape (12) en déplaçant ainsi la première soupape (12) vers sa deuxième position et une deuxième position où la première source de pression relativement réduite (46) est reliée de manière fluidique au troisième conduit (20, 22) et à la première soupape (12) en déplaçant ainsi la première soupape (12) vers sa première position;

(f) relier de manière fluidique une deuxième soupape (18) au troisième conduit (20, 22) entre la troisième soupape (24) et la première soupape (12); et
(g) déplacer la deuxième soupape (18) entre une première position où le fluide communique encre la première soupape (12) et la troisième soupape (24) et une deuxième position où là aucun fluide ne communique entre la première soupape (12) et la troisième soupape (24), indépendamment de la position de ladite troisième soupape (24).

18. Procédé selon la revendication 17, comportant en outre les étapes consistant à

(h) relier de manière fluidique une deuxième source de pression relativement accrue (34), une deuxième source de pression relativement réduite (30) et la deuxième soupape (18) à une quatrième soupape (28); et
(i) déplacer la quatrième soupape (28) entre une première position où la deuxième source de pression relativement accrue (34) est reliée de manière fluidique à la deuxième soupape (18) en déplaçant ainsi la deuxième soupape (18) vers sa deuxième position et une deuxième position où la deuxième source de pression relativement réduite (30) est reliée de manière fluidique à la deuxième soupape (18) en déplaçant ainsi la deuxième soupape (18) vers sa première position.

19. Procédé selon la revendication 17, selon lequel le troisième conduit (20, 22) comporte un conduit à mémoire (20), le procédé comportant en outre les étapes consistant à :

(h) relier de manière fluidique le conduit à mémoire (20) entre la première soupape (12) et la deuxième soupape (18) afin de maintenir la première soupape (12) dans sa première position ou sa deuxième position;
(i) déplacer la deuxième soupape (18) afin de déplacer la première soupape (12) entre sa première position et sa deuxième position; et
(j) déplacer la deuxième soupape (18) afin de maintenir un état de pression du conduit à mémoire (20) de façon à maintenir la première soupape (12) dans sa première position ou sa deuxième position en fonction de l'état de pression du conduit à mémoire (20).

20. Procédé selon la revendication 17, comportant en outre les étapes consistant à :

prévoir plusieurs premières soupapes (12), chacune des différentes premières soupapes (12) étant reliée de manière fluidique au premier conduit de transport de fluide (14) et au deuxième conduit de transport de fluide (16), chacune des premières soupapes (12) étant mobile entre une première position où le fluide communique entre le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16) et une deuxième position où aucun fluide ne communique entre le premier conduit de transport de fluide (14) et le deuxième conduit de transport de fluide (16);
prévoir au moins une deuxième soupape (18) et un nombre correspondant de troisième conduits (20, 22), chaque troisième conduit (20, 22) comprenant un conduit à mémoire (20);
relier de manière fluidique la au moins une deuxième soupape (18) à chacune des différentes premières soupapes (12) avec au moins un conduit à mémoire (20);
relier de manière fluidique la source de pression relativement accrue (48) ou la source de pression relativement réduite (46) à la au moins une deuxième soupape (18), la au moins une deuxième soupape (18) étant mobile entre sa première position où la source de pression relativement accrue (48) ou bien la source de pression relativement réduite (46) est reliée de manière fluidique au au moins un conduit à mémoire (20) et sa deuxième position où la source de pression relativement accrue (48) ou bien la source de pression relativement réduite (46) n'est pas reliée de manière fluidique au au moins un conduit à mémoire (20);
déplacer la au moins une deuxième soupape (18) vers sa première position afin de relier de manière fluidique le au moins un conduit à mémoire (20) et un premier sous-ensemble des différentes premières soupapes (12) à la source de pression relativement accrue (48) ou bien à la source de pression relativement réduite (46) et afin de déplacer le premier sous-ensemble des différentes premières soupapes (12) une première position prédéterminée de sa première position en de sa deuxième position en réponse à la pression relativement accrue ou à la pression relativement réduite;
déplacer la au moins une deuxième soupape (18) vers sa deuxième position en maintenant ainsi le premier sous-ensemble des différentes premières soupapes (12) dans la première position prédéterminées de sa première position et de sa deuxième position; et
relier de manière fluidique la source de pression relativement accrue (48) ou la source de pression relativement réduite (46) à un deuxième sous-ensemble des différentes premières soupapes (12) afin de déplacer le deuxième sous-ensemble des différentes premières sou-

papes (12) vers une deuxième position prédéterminée de sa première position et de sa deuxième position en réponse à la pression relativement accrue ou à la pression relativement réduite.

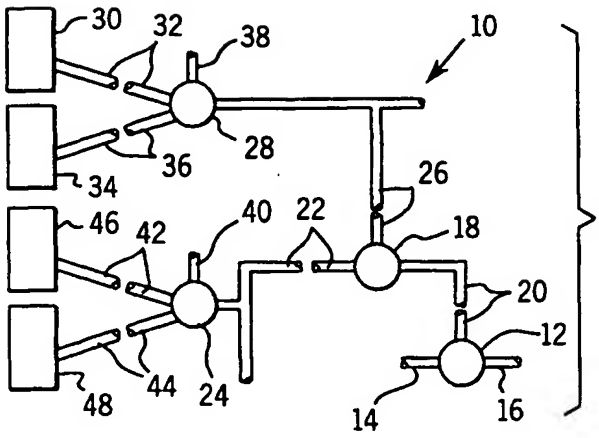

FIG. 1

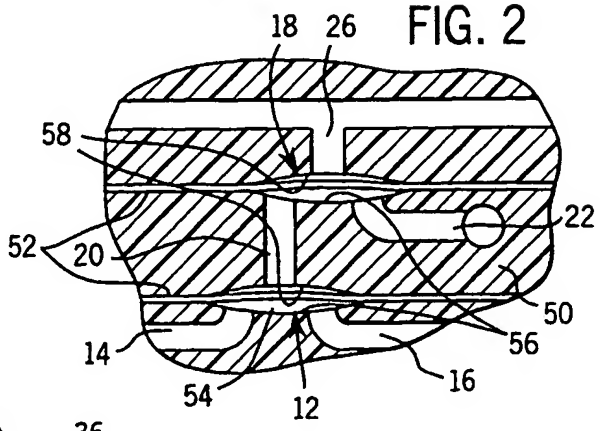

FIG. 2

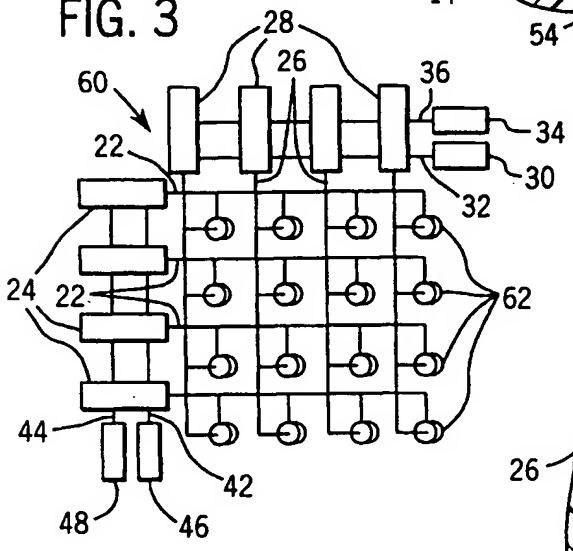

FIG. 3

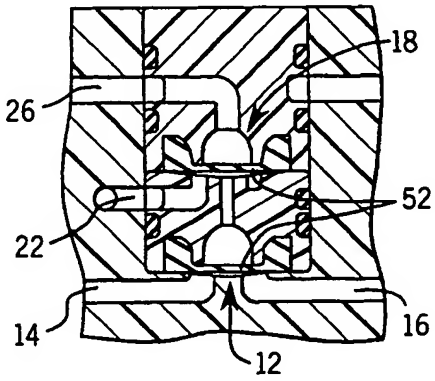

FIG. 4